



Defense Modeling and Simulation

23 May 2000

Dr. Delores M. Etter

Deputy Under Secretary of Defense (Science & Technology)

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DoD Science & Technology Mission



To ensure that the warfighters today and tomorrow have superior and affordable technology to support their missions, and to give them revolutionary war-winning capabilities.



Revolutionary Capabilities

Stealth



***Adaptive
Optics and
Lasers***



Night Vision



DoD S&T

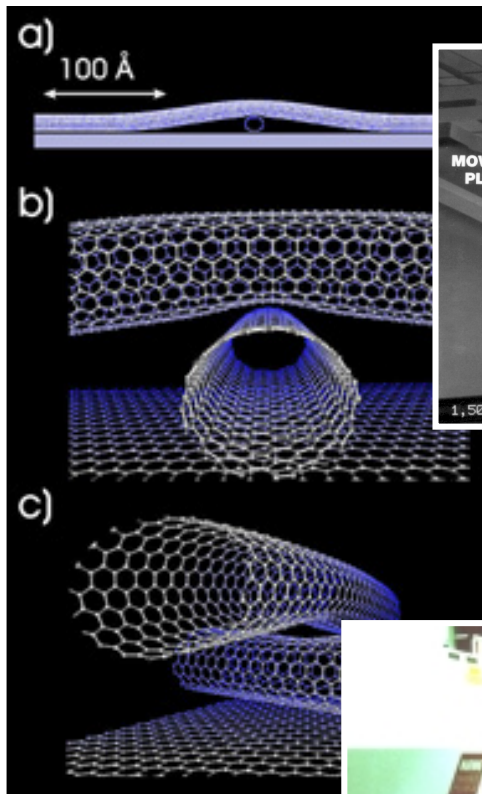
GPS



Phased Array Radar

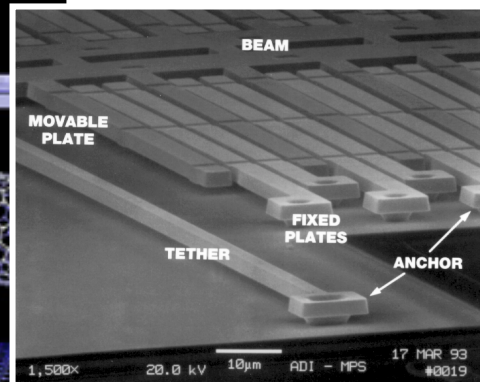


Current S&T



Nanoscience

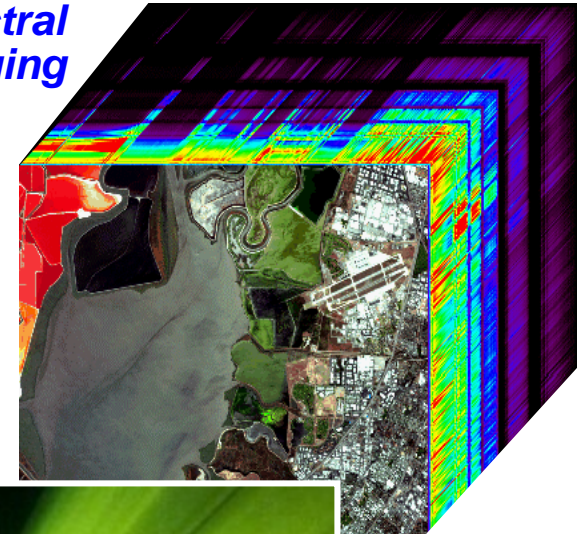
Biolab



MEMS
*microelectromechanical
systems*

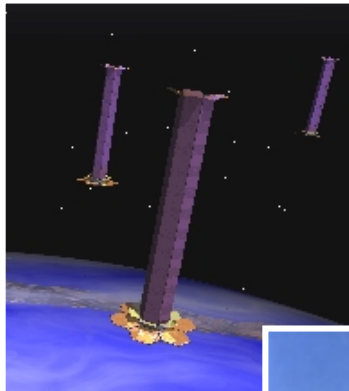


*Hyperspectral
Imaging*



Starfire

Future Revolutionary Capabilities



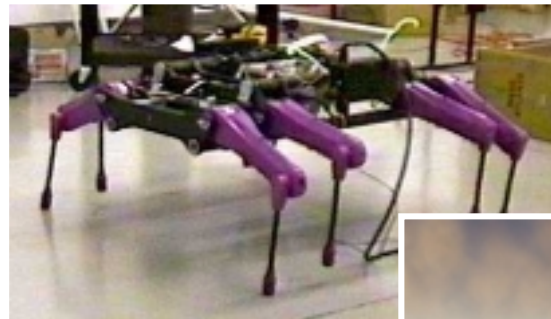
Microsatellites



Joint Strike Fighter



Micro Air Vehicles



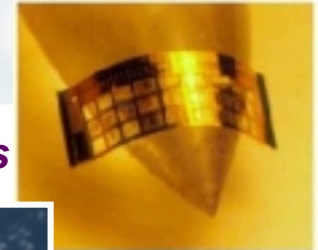
Micro Robots



DD-21



Flexible Sensor Skins



Augmented Reality

Bio Sensors



Embedded Biofluidic Chips



Handheld



Changing Environments



Security Threats

States that Threaten
International Peace
and Security

International Crime
Organizations

Transnational Actors/
Terrorists

Weapons of
Mass Destruction

21st Century

Conflict Increasing

Proliferation of Military and
Commercial Technologies

Operations in Urban
Environments

Preponderance of Coalitions

Ethnic Strife

Impact

Greater Range of
Solutions

No US Monopoly in
all Technologies

Complex Targets/Terrain

Information
Management Critical

FY00 RDT&E



FY00 RDT&E = \$37.6B
(6.1 thru 6.7)

(\$B)

(6.6 + 6.7 = \$14.8B)

Development
(6.4 + 6.5 = \$14.4B)

36
32
28
24
20
16
12
8
4
0

6.7 Operational Systems Development (\$12.2B)

6.6 RDT&E Management Support (\$2.6B)

6.5 Engineering and Manufacturing Development (\$7.9B)

6.4 Demonstration and Validation (\$6.5B)

6.3 Advanced Technology Development (\$3.8B)

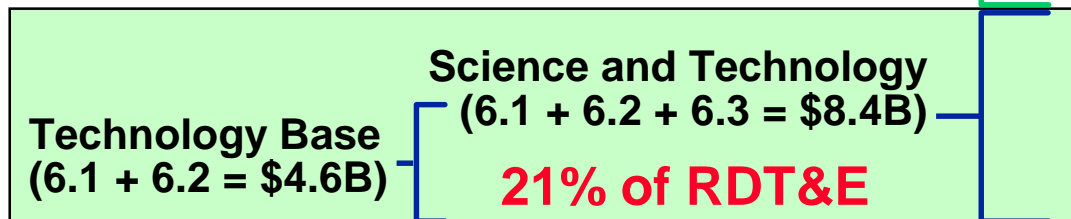
6.2 Applied Research (\$3.4B)

6.1 Basic Research (\$1.2B)

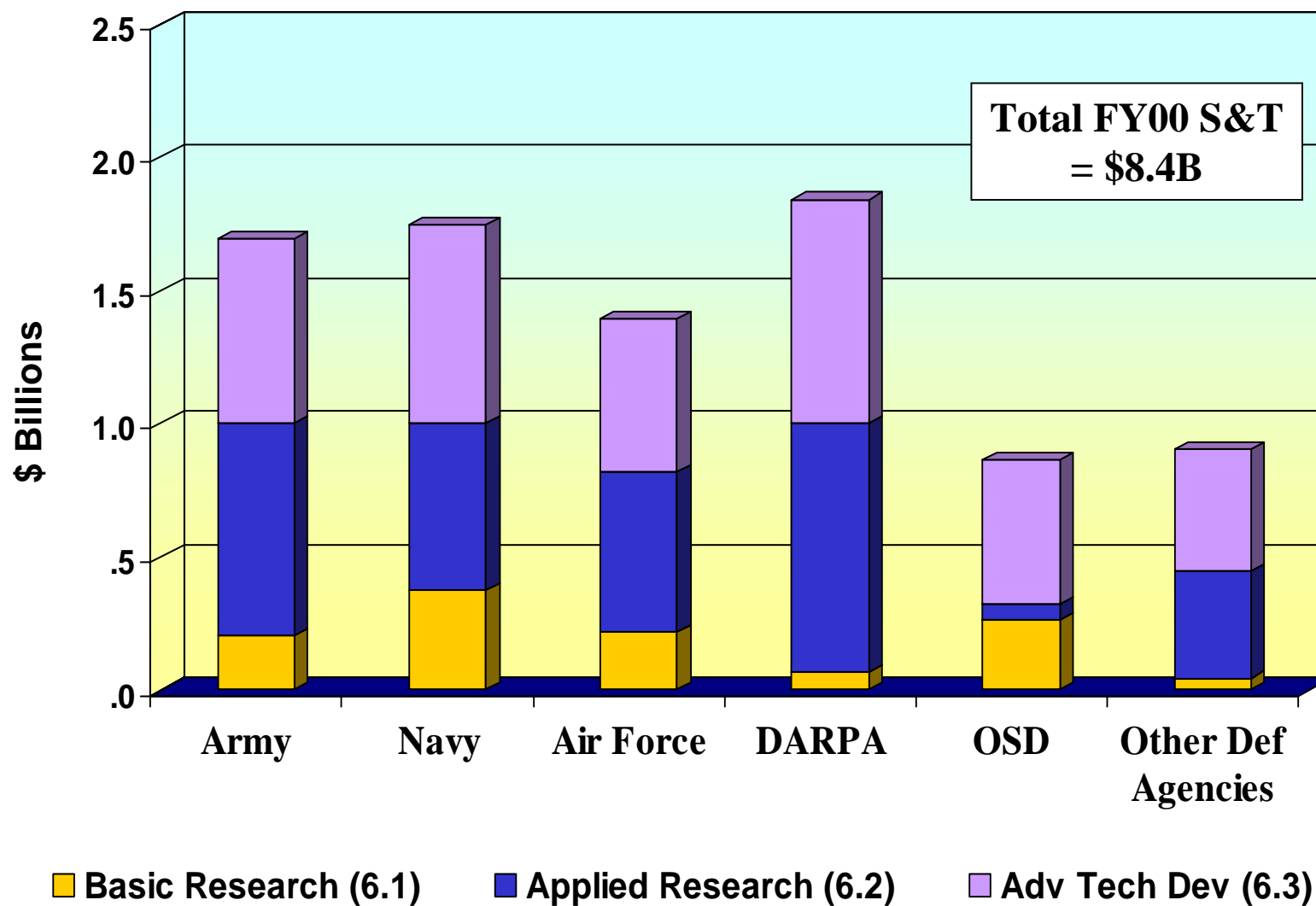
Science and Technology
(6.1 + 6.2 + 6.3 = \$8.4B)

Technology Base
(6.1 + 6.2 = \$4.6B)

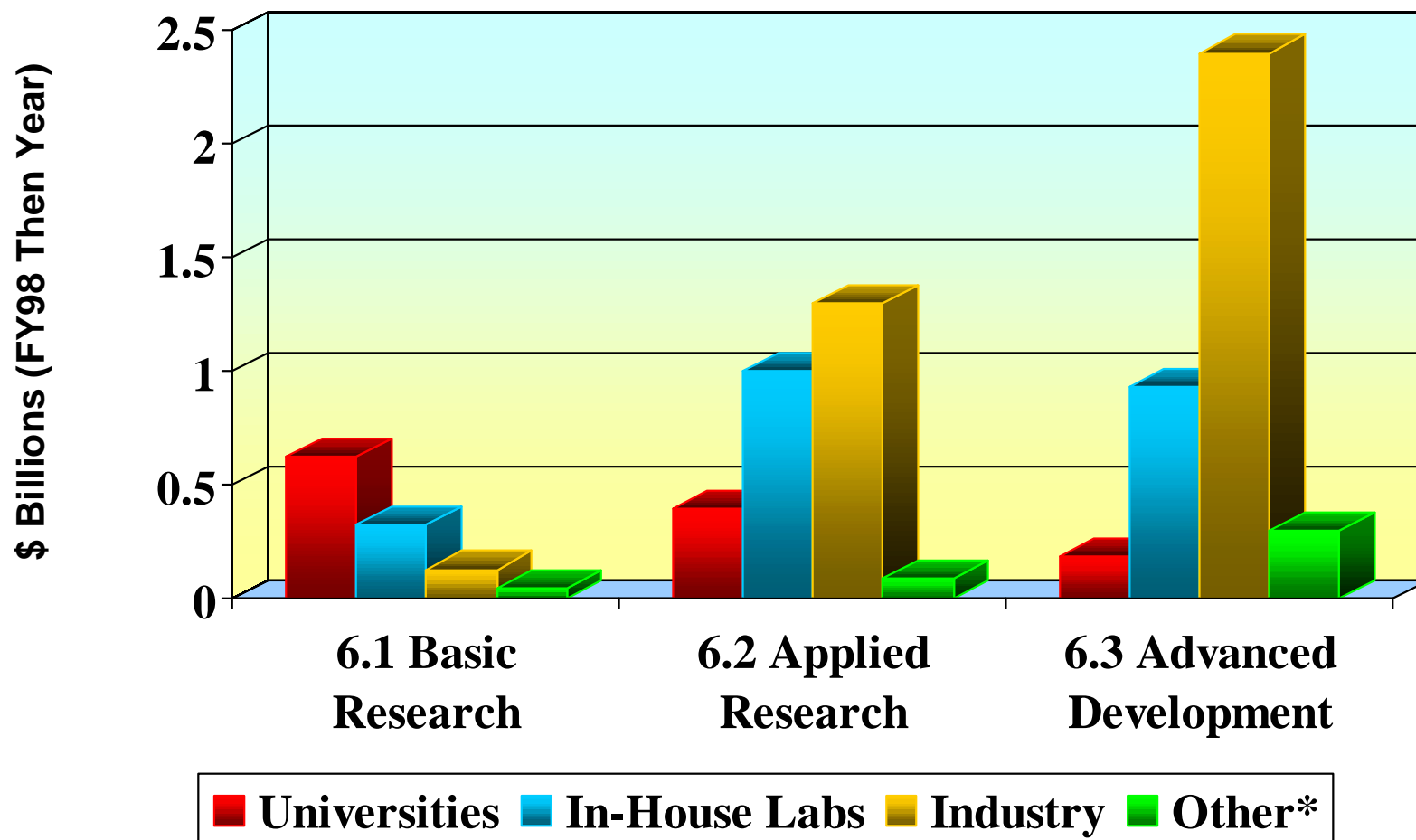
21% of RDT&E



DoD S&T Investment



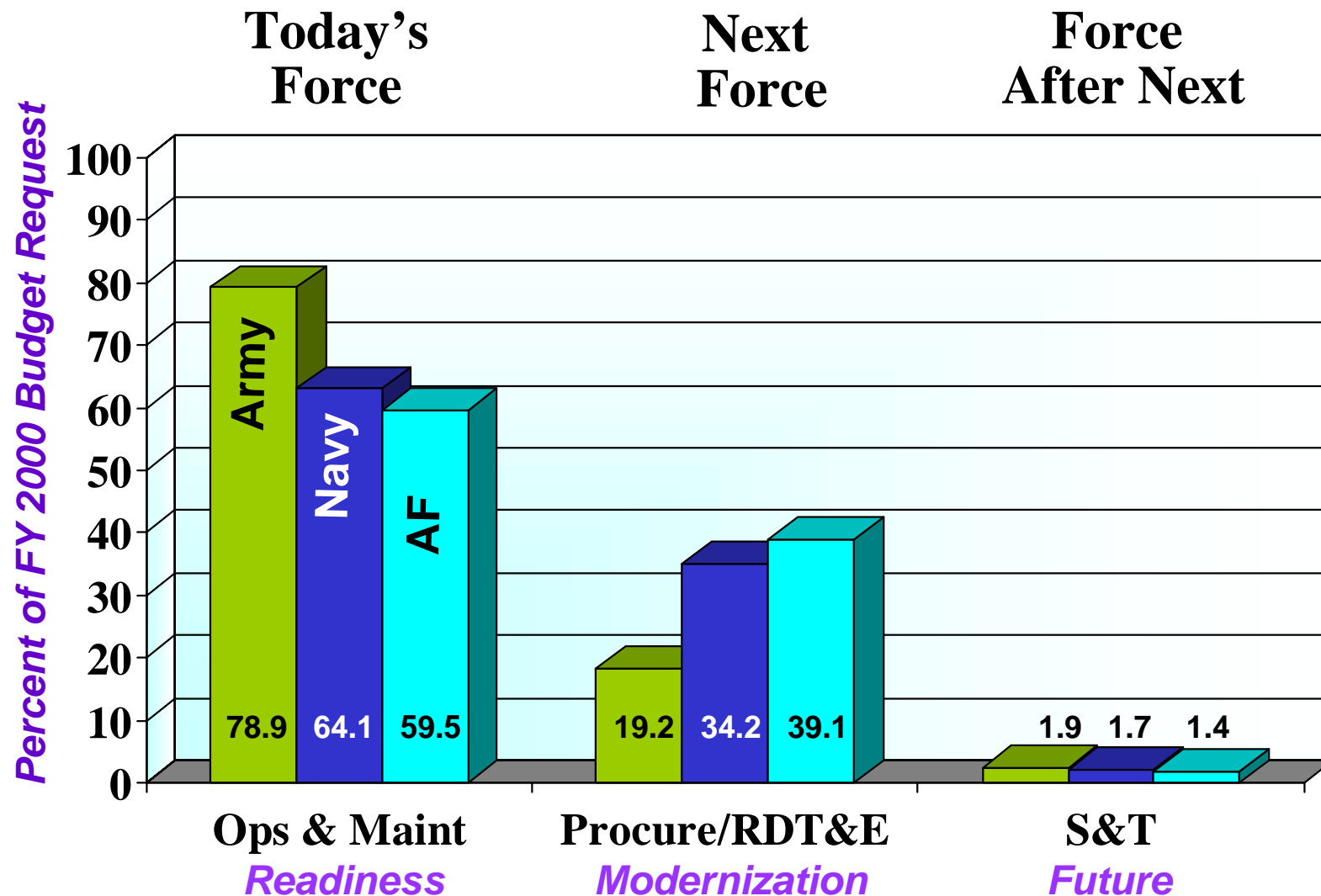
Recipients of DoD S&T Funds



***Includes non-profit institutions, State & local govt., & foreign institutions**

Source: National Science Foundation Report, NSF 98-332 (FY 1998)

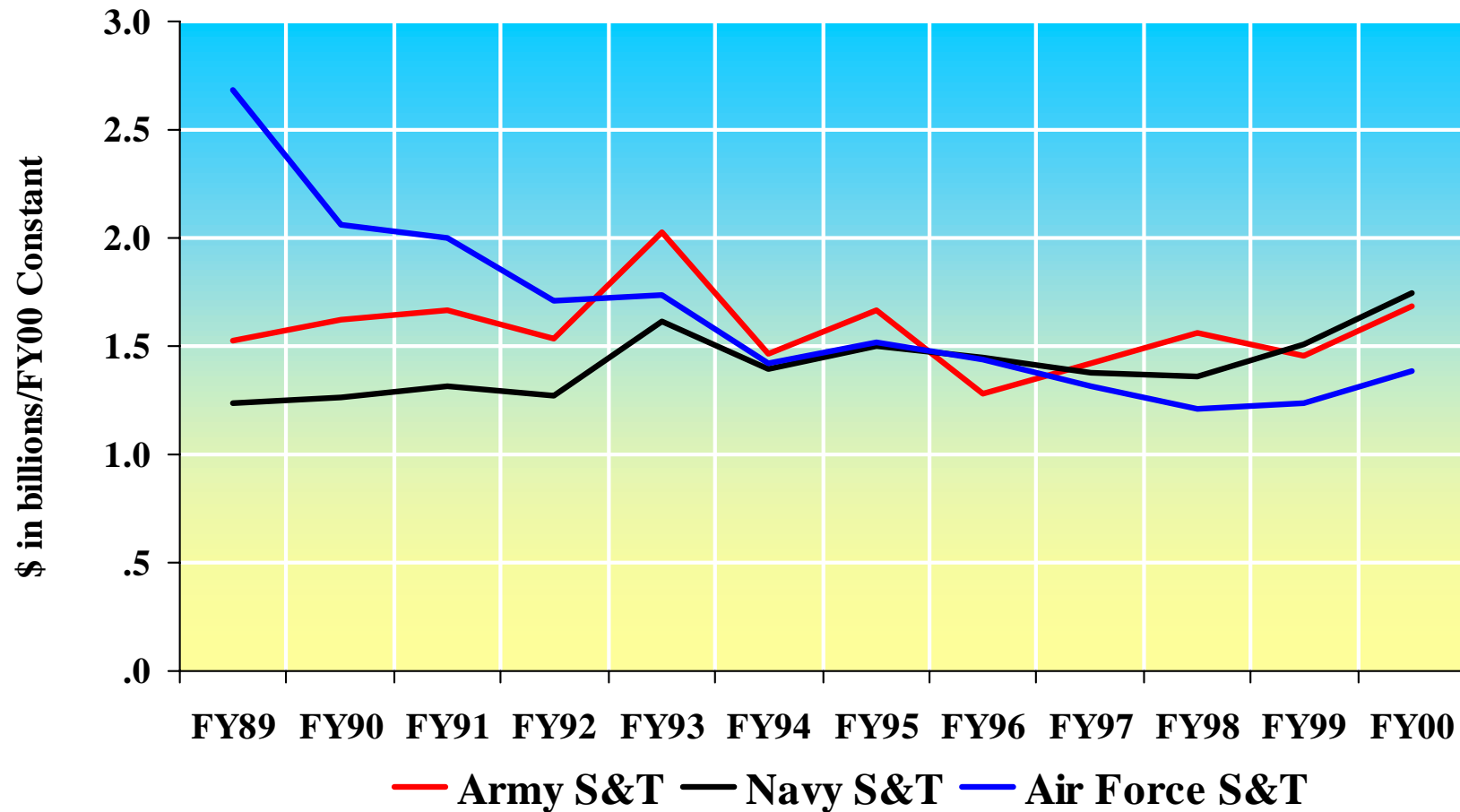
Technology Perspectives FY00 Appropriated



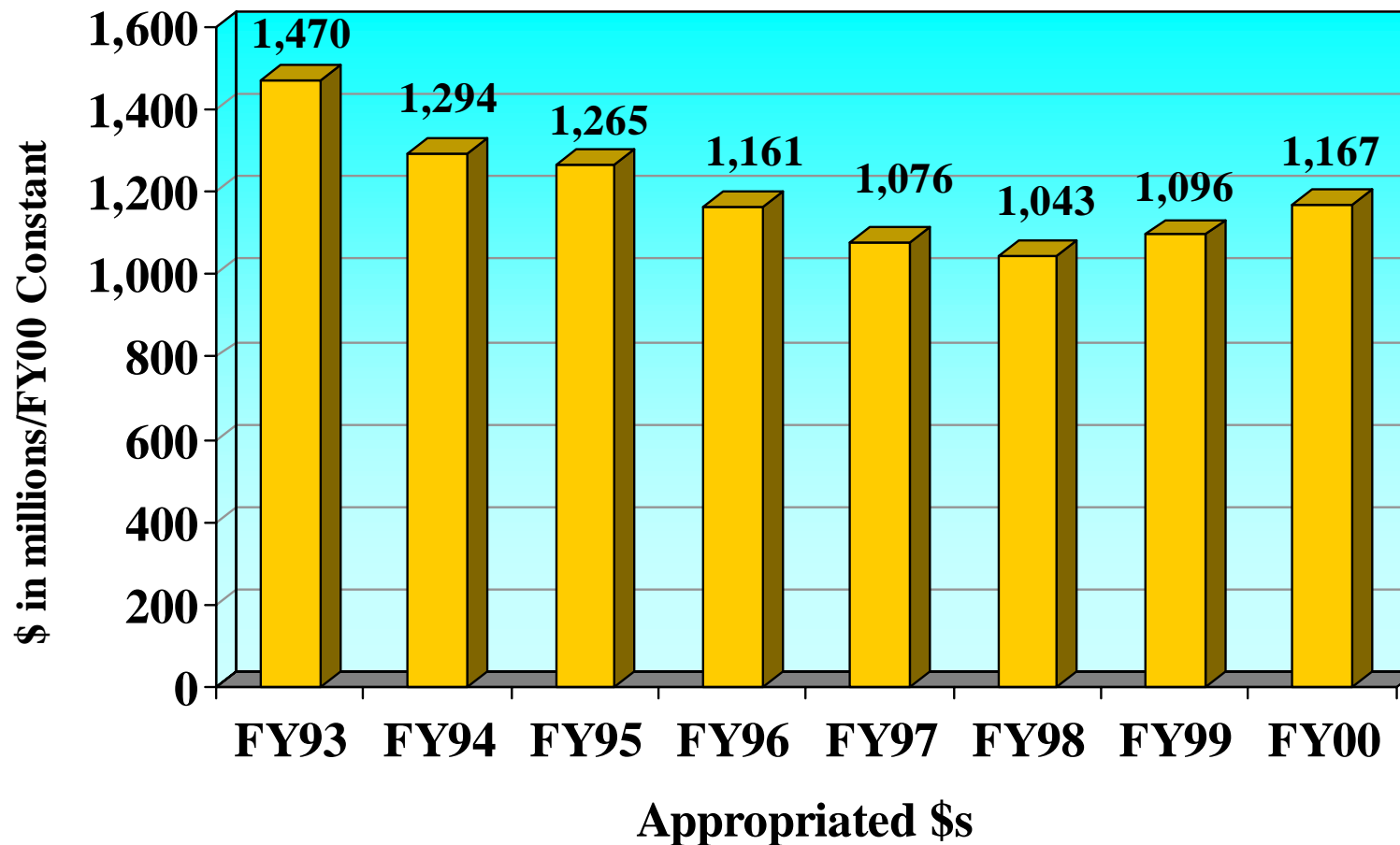
Service Investment in Science & Technology



Services Science & Technology (S&T) (6.1, 6.2, 6.3)



DoD 6.1 Basic Research



**Basic Research funding down over \$300M
(~21%) in purchasing power since 1993**

DUSD (S&T) Priorities (2000)

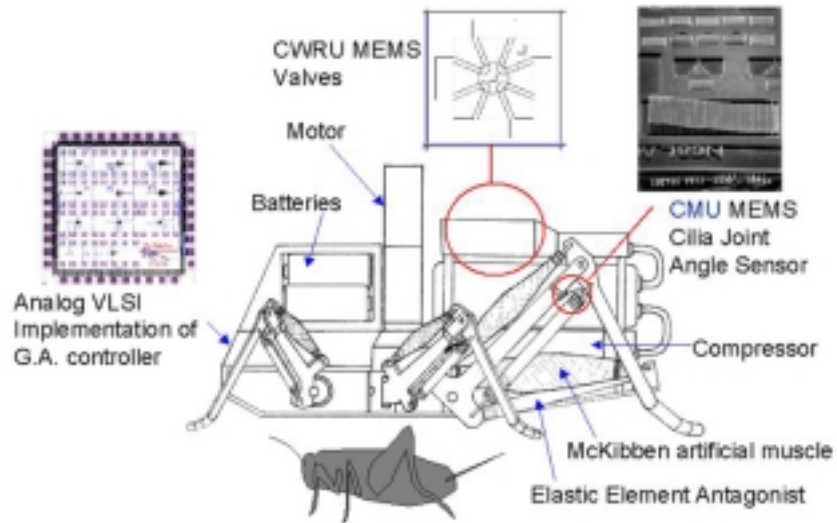


- Basic Research
- Five Focus Areas
 - Chemical & Biological Defense
 - Information Assurance
 - Hardened & Deeply Buried Targets
 - Smart Sensor Web
 - Cognitive Readiness
- Cross Cutting Initiatives
 - Software Intensive Systems
 - High Performance Computing
 - Modeling and Simulation
- Technology Transition Watch/Exposition
- S&T Pilot Laboratory Program

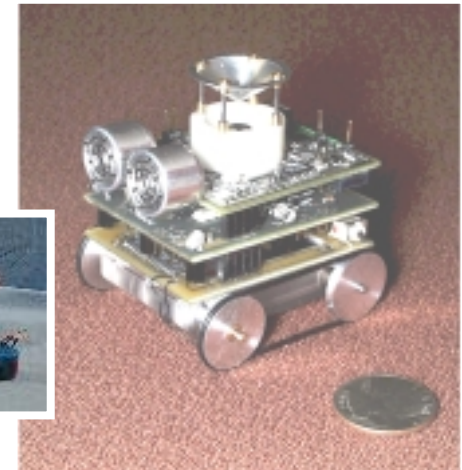
Microrobotics



Cricket Micro-Robot



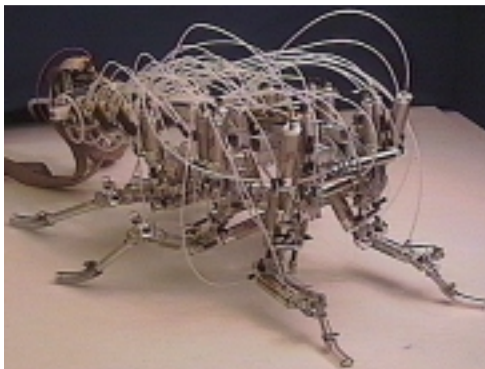
Millibots



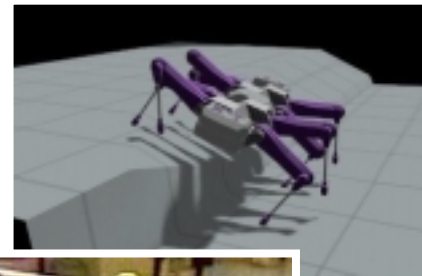
Mini Flail



Robot III



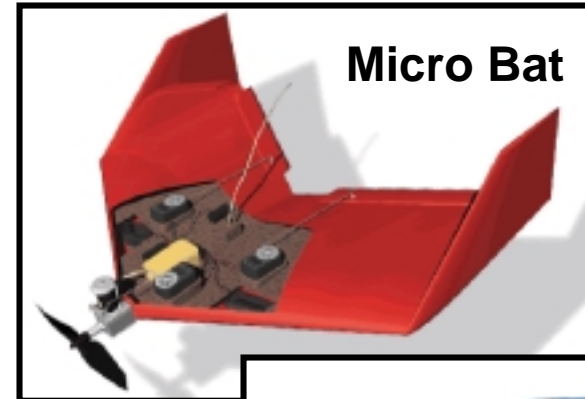
K²T



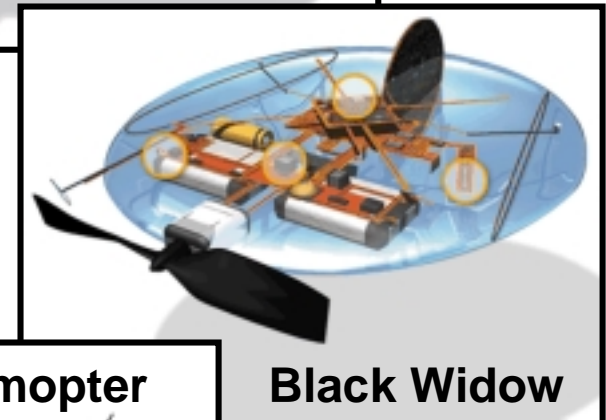
Basic Research-Micro Air Vehicles



MAVs
(3.5 in. and
6 in. models)

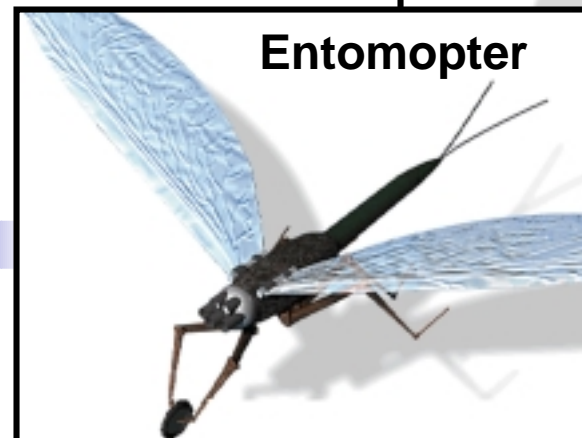
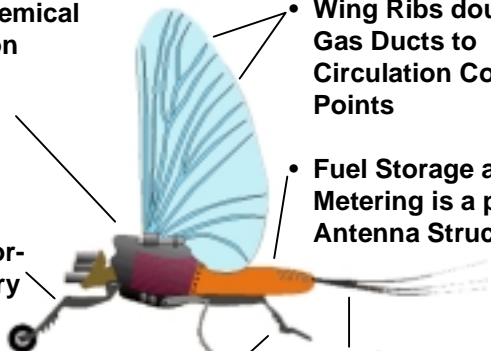


Micro Bat



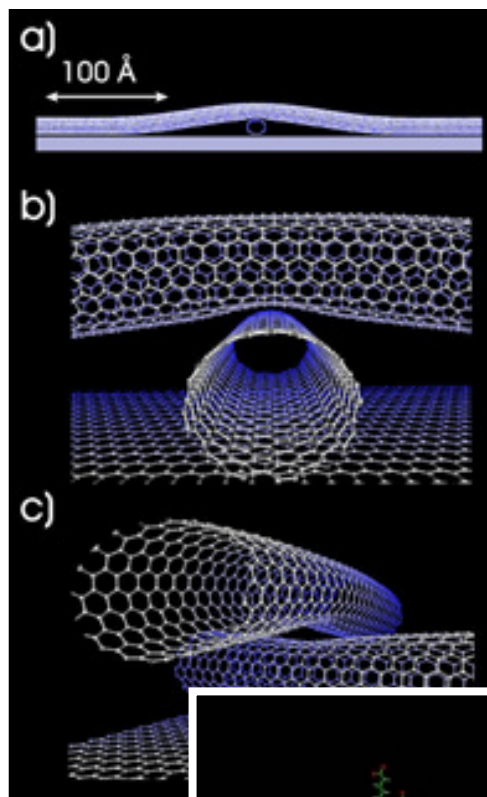
Black Widow

- Exoskeletal Chemical Muscle Reaction Chamber
- Exhaust Ports
- Wing Hinges
- Thermoelectric Generator
- Intensity Sensor-Actuated Trinary Steering
- Inflight, widely spread Surface Locomoters provide Anti-Roll Inertia with auxiliary fuel storage (mass) in legs/feet.
- Wing Ribs double as Gas Ducts to Circulation Control Points
- Fuel Storage and Metering is a part of Antenna Structure
- Antennas double as Trim Stabilizers

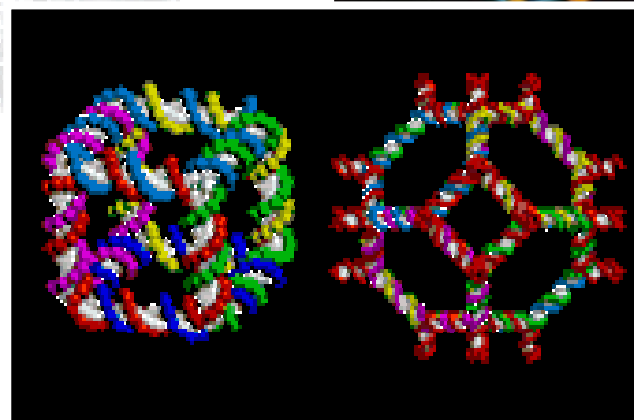
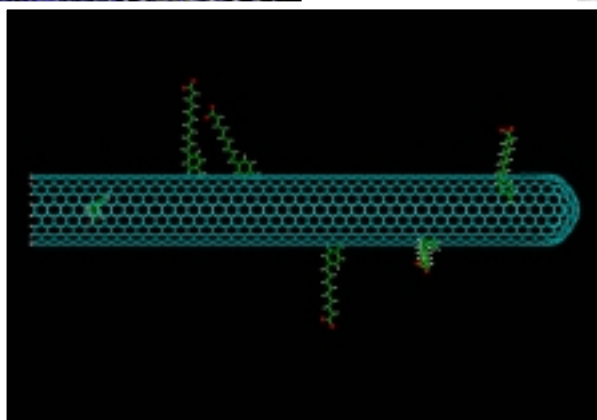
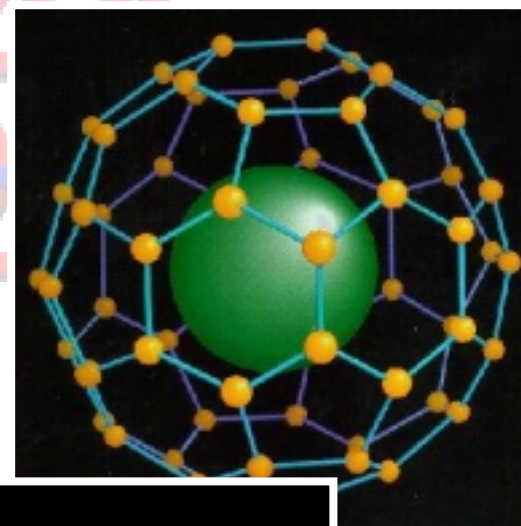


Entomopter

Nanoscience



- ***Carbon Computers***
- ***Molecular Engineering***
- ***Nanoscale robots, sensors, machines***
- ***Battery Electrode and Energy Storage***
- ***Vacuum Microelectronics Devices***
- ***Molecular Composites***



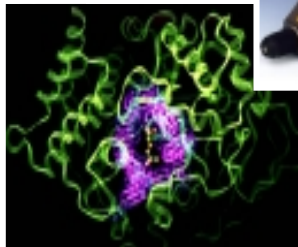
Chemical & Biological Defense



Inexpensive Weapon Proliferation

Chemical Agent
Biological Agent

Detection
Protection
Decontamination
Agent Dispersal Modeling



Information Assurance



Cyberterrorism

Hackers
Inside Attacks
Information Warfare

Firewalls
Malicious Code Detectors
Encryption
Correlation Technologies



DoD Science & Technology

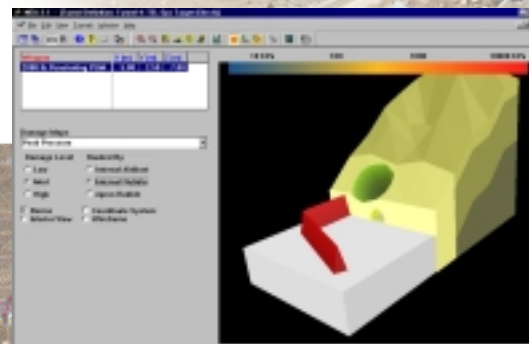
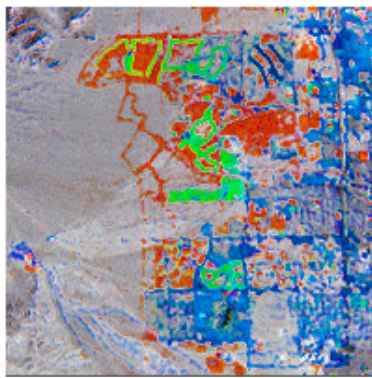
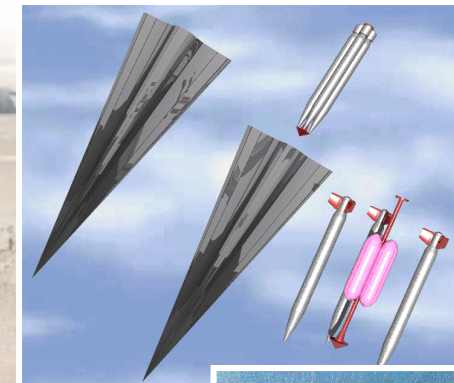
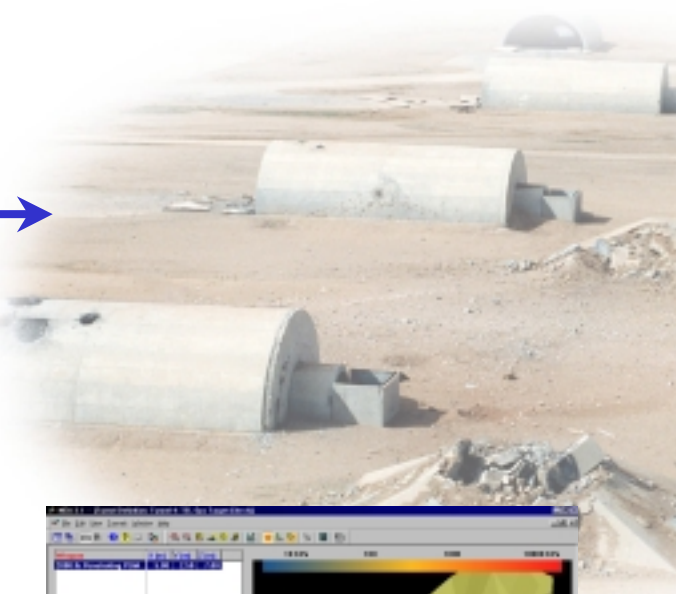
Hardened and Deeply Buried Targets



WMD and Missile Concealment

Detection
Characterization
Neutralization

Overhead Imagery
Computational Modeling
Sensors
Delivery Systems



Smart SensorWeb



Complete Situation Awareness

Real-time Imagery
Micro-Weather
Moving Targets
Integration


Physical Models
Dynamic Data Bases
Micro Sensors
Wireless Communications
Next Generation Internet



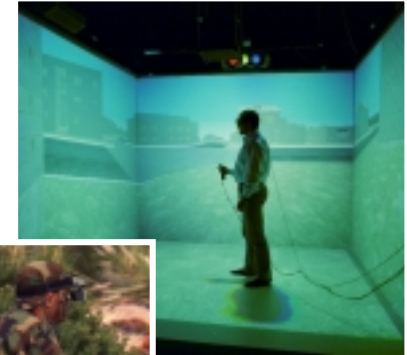
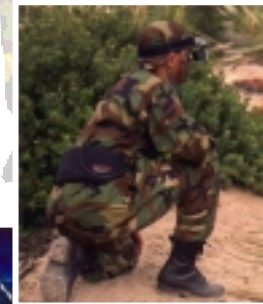
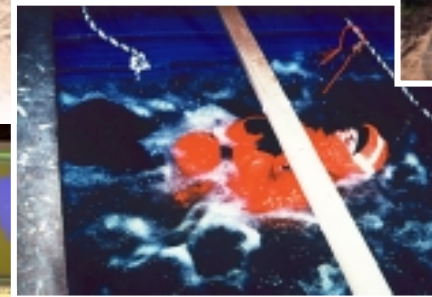
DoD Science & Technology



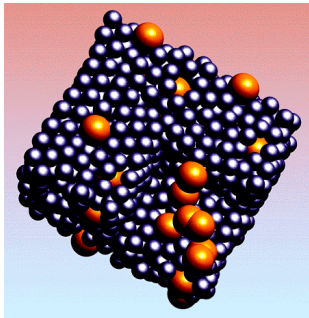
Sustained Operations
Environmental Ambiguity
Distributed Learning
Information Overload



Physiological Monitoring
Embedded Training
Learner-centric Instruction
Augmented Reality

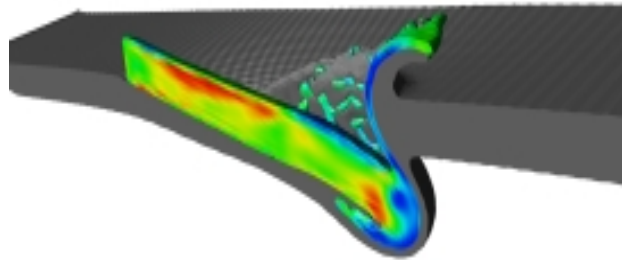


Impact of Software, HPC and M&S



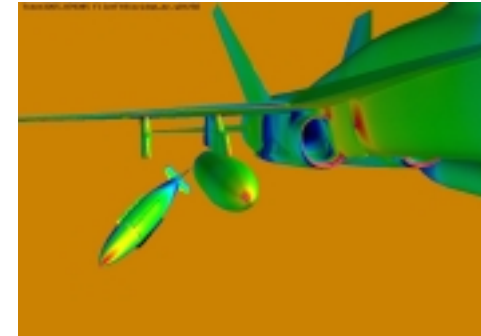
Basic Research

Simulating High-Energy
Density Rocket Fuels



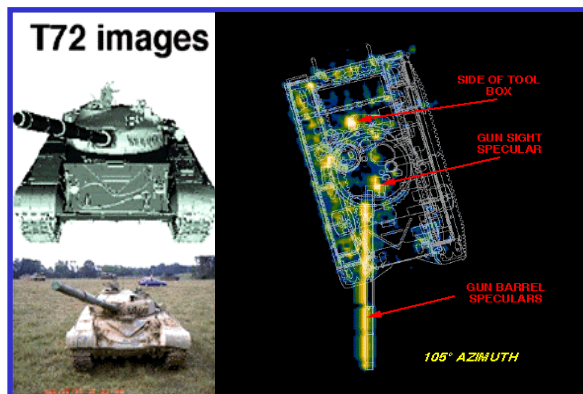
Advanced Technology

Armor and Projective Design



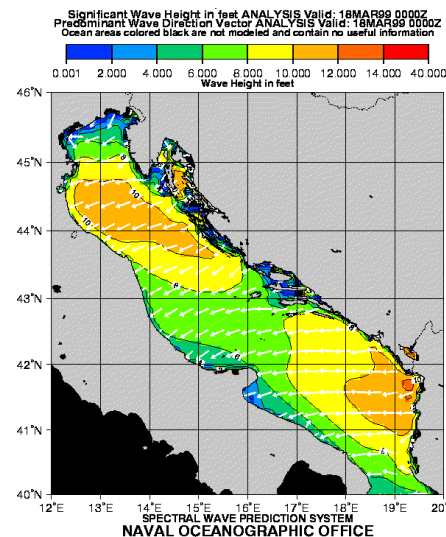
Developmental T&E

Support of Aircraft-Store
Compatibility and Weapons
Integration



Intelligence

Radar Cross-Sections Predictions



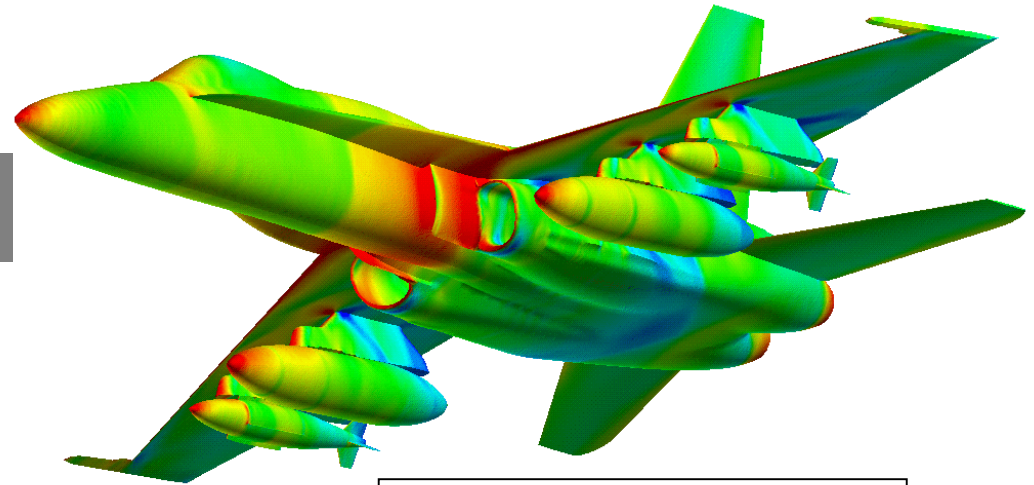
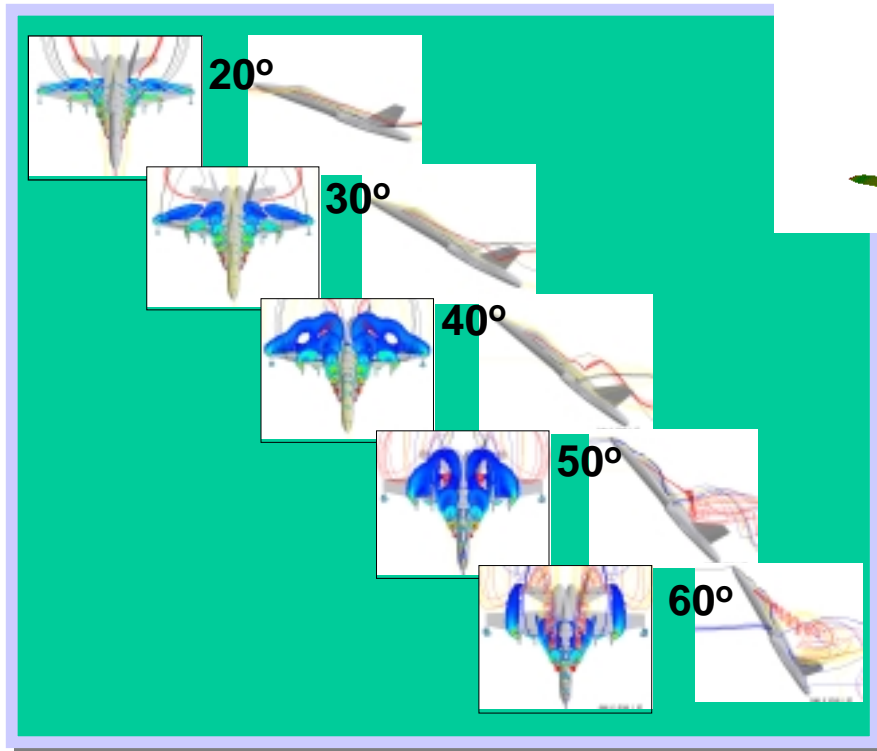
Operations

Ocean/wave forecasting

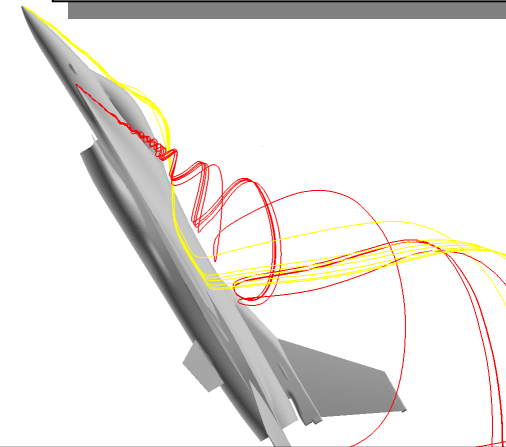
Contributions to Aircraft Design & Analysis



Unsteady Aerodynamic Analysis



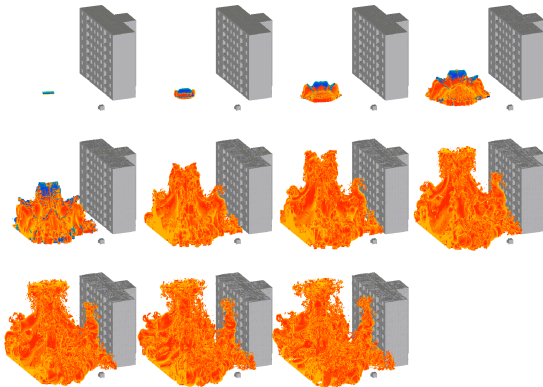
Stores Certification



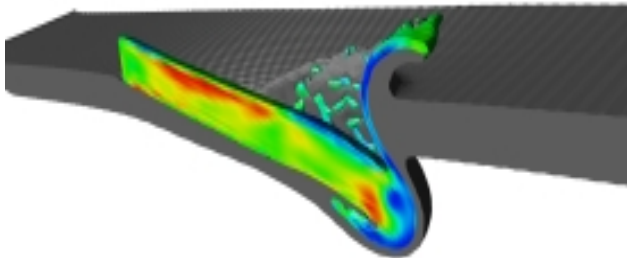
Nose-slice Departure

Significant to National Security

CTH – Shock Physics Software



Objective: Evaluate blast effects on multi-story building structures



Objective: Armor and projectile design

Application Software – CTH:

- Developed at DOE/SANDIA
- Investment: +100 labor-years
- Size: 250,000 lines of code

Codes are classified or ITAR restricted; Data frequently classified

Middleware:

- Operating system (Unix)
- Compilers (FORTRAN 77, C)
- Message passing library (MPI and PVM)

Availability varies from commercial to public domain

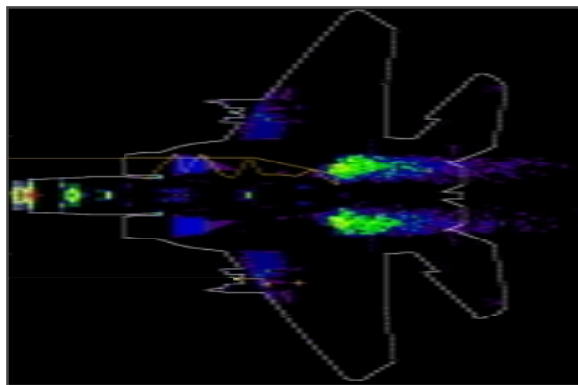
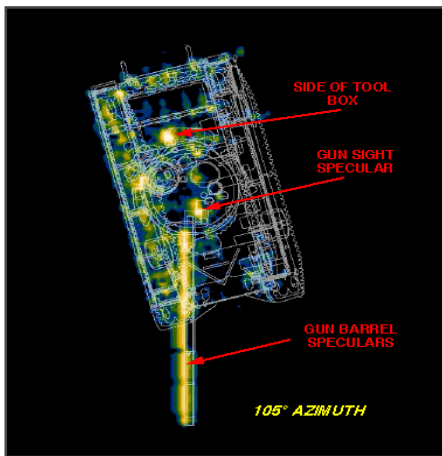
Computer Hardware:

- Systems: IBM SP, Cray T3E, SGI Origin 2000
- CTH simulations utilize up to 256 processors

Commercial

Significant to National Security

Xpatch – Radar Signature Software



Objective: Prediction of radar cross section (RCS) for tanks and aircraft

Application Software – Xpatch:

- Developed via Air Force R&D contracts
- Investment: 150 labor-years
- Size: 1.5 million lines of code

Codes are classified or ITAR restricted; Data frequently classified

Middleware:

- Operating system (Unix)
- Compilers (FORTRAN 90, C, C++)
- Message passing library (MPI)

Availability varies from commercial to public domain

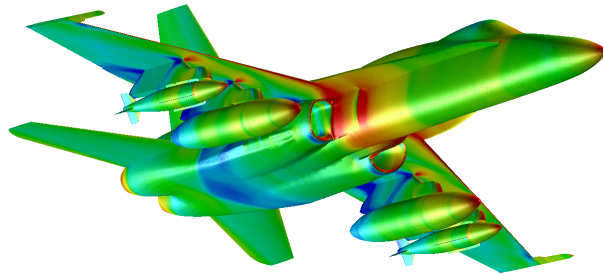
Computer Hardware:

- Systems: IBM SP, SGI Origin 2000
- Xpatch simulations utilize up to 64 processors

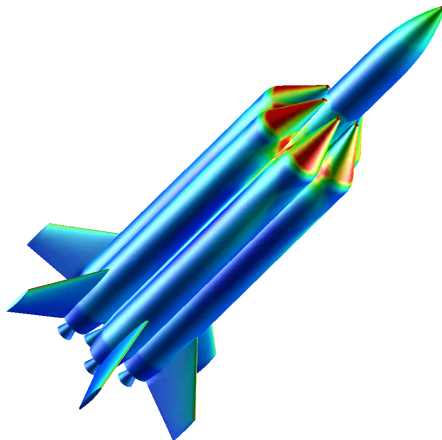
Commercial

Significant to National Security

Cobalt – Computational Fluid Dynamics Software



Objective: Analyze flow over an F-18



Objective: Evaluate flight conditions for future low cost launch system

Application Software – Cobalt:

- Developed at AFRL
- Investment: 15 labor-years
- Size: 30,000 lines of code

Codes are classified or ITAR restricted; Data frequently classified

Middleware:

- Operating system (Unix)
- Compilers (FORTRAN 90, C)
- Message passing library (MPI)

Availability varies from commercial to public domain

Computer Hardware:

- Systems: IBM SP, Cray T3E, SGI Origin 2000
- Cobalt simulations utilize up to 200 processors

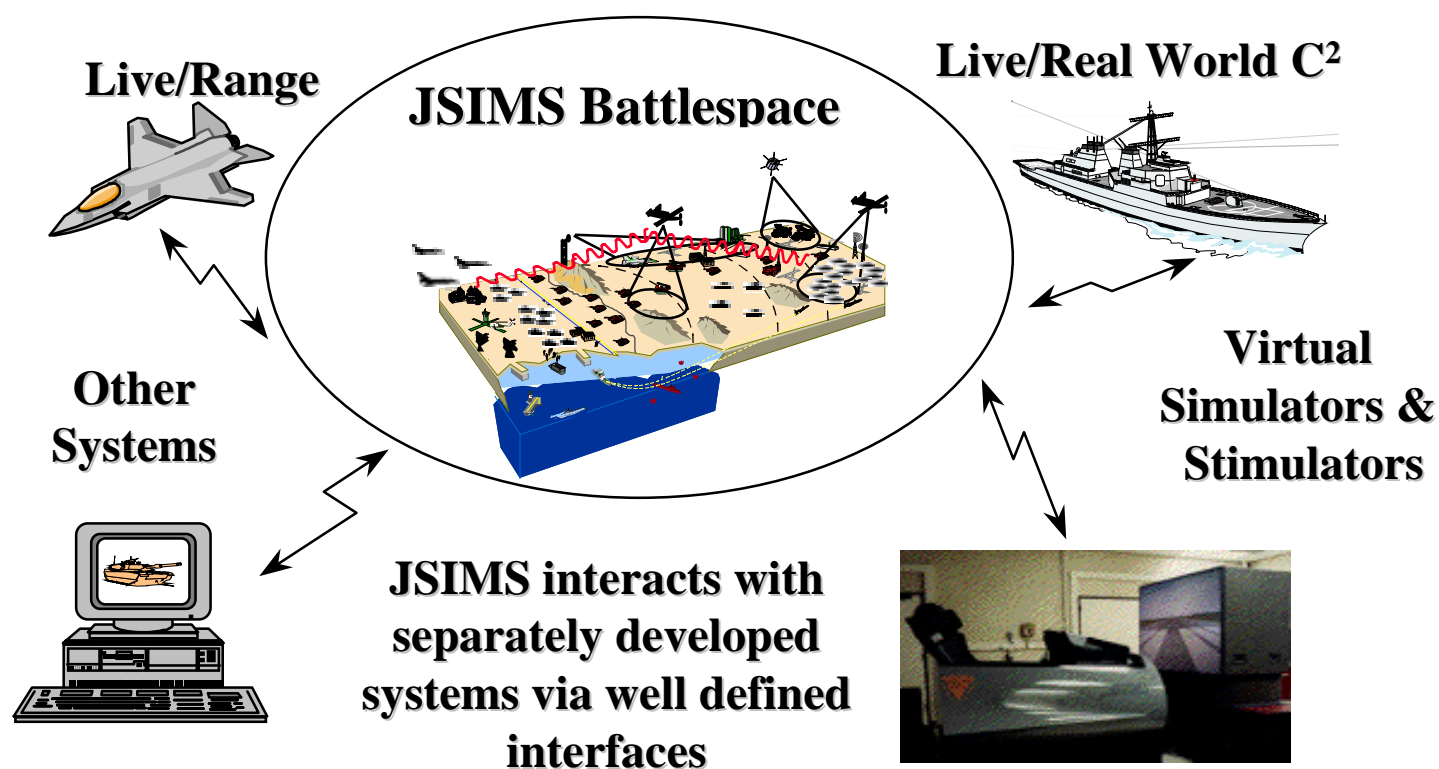
Commercial

DoD M&S Programs - JSIMS

<http://www.jsims.mil>



JSIMS creates a simulation capability to support Joint or Service training, rehearsal, or education objectives.



Examples of DMSO Successes



- Standards - High Level Architecture
- Framework for Representing Environment - Synthetic Environment Data Representation & Interchange (SEDRIS)
- Repositories for Models
- Modeling and Simulation Information Analysis Center (MSIAC)
- Education and Tutorial Programs

DMSO “New Vector” For the Future



Focus on the Warfighter Requirements

- **Lead** M&S in Development of New Revolutionary Capabilities for - Human Behavior, Synthetic Natural Environment
- **Integrate** M&S Activities within Community and Joint Programs - JSIMS, Smart Sensor Web
- **Leverage** Advances to Give Defense M&S New Capabilities - S&T Initiative, Advanced Training

DoD S&T is a Partnership

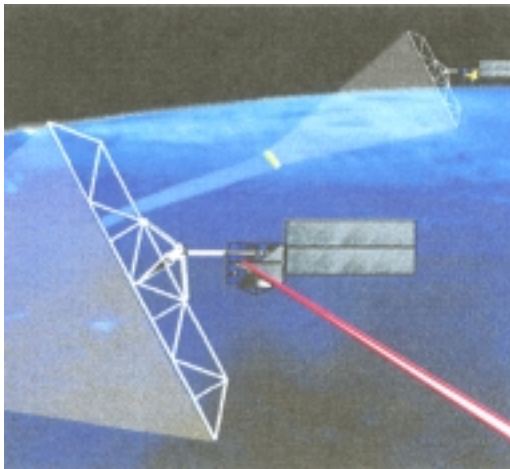


Stable, Long Term Investment



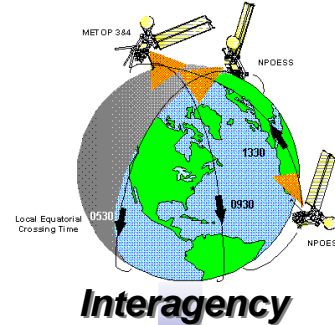
Service Labs

DARPA



High Risk, High Payoff

Expanded Resource Base



Interagency

New Ideas, Knowledge



Universities

Industries



Innovation, Transition

Maximum National Security Payoff

International



Coalition Capability

*Technical Superiority is
Critical for National Security.*

*In peace, it provides deterrence;
In crisis, it provides options;
In war, it provides an edge.*

